# Fungi Severity And Relative Rot Susceptibility Of Sweetpotato Cultivars Grown In Ebonyi State

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**Abstract:** Postharvest deterioration is a major constraint to sweet potato production and understanding the interactions between pathogen and crop are necessary for the development of disease control practices. This study evaluated the severity of sweet potato postharvest fungi and relative rot susceptibility of two sweet potato cultivars ('Oyorima' and 'Tupiaochi') commonly grown in Ebonyi State. The healthy roots of the two sweet potato cultivars were subjected to artificial rot induction by seven fungi- Botryodiplodia theobromae, Fusarium solani, Aspergillus flavus, Aspergillus niger, Penicillium expansum, Rhizopus oryzae and Aspergillus awamori isolated and confirmed responsible for postharvest spoilage of sweet potato in Ebonyi State in a previous study. The postharvest fungi exhibited moderate to very high severity on the roots. Both local varieties of sweet potato ('Oyorima' and 'Tupiaochi') tested showed moderate to very high susceptible to postharvest fungal rot, with susceptibility varying with the pathogen and sweet potato cultivar. The Cultivar and pathogen interaction for cultivar 'Tupiaochi' was significantly (P=0.05) higher than that of 'Oyorima'. There is therefore the need to regulate the storage environment for sweet potato roots since cultivar susceptibility to infection is influenced by the prevailing environmental conditions. Moreover, the use of improved sweet potato varieties, good storage facilities and adequate control measures need to be encouraged in order to reduce storage rot of sweet potato roots in Ebonyi State.

**Key Word:** Fungi, Severity, Postharvest Rot, Susceptibility, Sweet potato Cultivars, Ebonyi State.

## 1. INTRODUCTION

Harvested sweet potato roots are prone to infection by a wide range of microorganisms resulting in decay. Bacteria and fungi can affect sweet potato in storage, with fungi being the most common and destructive postharvest pathogen. Different genera of fungi have been reported to induce rot and spoilage in stored sweet potato [8] and [9]. Synthetic fungicides are effective in the control of postharvest decay but they have several drawbacks because of which they are seldom adopted by farmers for use on a postharvest context. Due to the perceived negative effects that chemical fungicides pose and the problem of fungicide resistance, there is an international demand for the discovery of safer alternatives that can control postharvest diseases adequately [9].This demand has opened the door for search of an alternative measures to control postharvest diseases. An important component of any alternate disease control system is cultivar resistance; that is the cultivation of non susceptible crop cultivar. Cultivar susceptibility is the inability of host plants (the cultivar) to control the severity of the infection when environmental conditions favour the pathogen. Variation in susceptibility to pathogenic infections is a function of the host genetic structure [2], the duration of the storage period, the type of wound that provides pathogen entry, constant genotype-by-environment interactions, host nutrient status and host age). The availability of cultivars that are less susceptible to fungi rot provides an opportunity to lower the potential for infection at a number of stages.


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For instance, resistant plant genotypes can help constrain disease symptoms due to infections and limit pathogen spread. On the other hand, genotypes susceptible to infection may increase pathogen spread owing to their greater pathogen quantity, regardless of their symptom status [2]. In agricultural systems, among-individual variability may be minimized by the use of a particular cultivar, where a certain genotype is desirable because of its associated economic value. In practice this can result in significant yield loss if the plant genotype is susceptible to pathogens [5]. However, post-infection plant resistance can be achieved through defensive mechanisms that either negatively impact the pathogen by limiting its multiplication and reducing its population (i.e. resistance), or by limiting its impact on host phenotype (i.e. tolerance). The use of host resistance for disease management is appropriate because it ensures customer safety and minimum cost and labour to the producer. Sweet potato genotypes are known to vary widely in their susceptibility to postharvest pathogens and diseases. Understanding the interactions between pathogen and crop are necessary for the development of disease control practices. However, there is paucity of information on the relative severity of the postharvest pathogen of sweet potato and rot susceptibility of the local cultivars of sweet potatoes commonly cultivated in Ebonyi State. This study was therefore aimed at investigating the postharvest pathogen severity and relative rot susceptibility of two sweet potato cultivars ('Oyorima' and 'Tupiaochi') commonly grown in Ebonyi State

## 2. MATERIALS AND METHODS

**2.1 Collection of Sweetpotato Roots:** Healthy roots of two sweet potato cultivars ('Tupiaochi' and 'Oyorima') most commonly cultivated in Ebonyi State were bought from Ebonyi sweetpotato farmers into jute bags and taken to the laboratory for investigation.

**2.2 Test Fungi:** seven fungi including Botryodiplodia theobromae, Fusarium solani, Aspergillus flavus, Aspergillus niger, Penicillium expansum, Rhizopus oryzae and Aspergillus awamori isolated on a Potato Dextrose Agar and confirmed responsible for postharvest spoilage of sweet potato in Ebonyi State in a previous study (Alum et al., 2019a) were employed in the study.

**2.3 Fungi Pathogenicity:** Two sweet potato varieties ('Tupiaochi' and 'Oyorima') were subjected to rot induction by the test fungi according to the method described by Amienyo and Ataga (2006). Fresh, healthy sweet potato roots were washed with tap water, rinsed with distilled water, weighed and surface sterilized with 70% ethanol. The initial weight of the storage roots was determined. Cylindrical discs were then removed from the root with a sterile 4mm cork borer and a disc of a five-day old pure culture of each test isolate was inoculated into the hole created in the roots with the aid of another cork borer (4mm diameter). The tissue part bore out were carefully replaced after the inoculation, sealed with sterile vaseline and labeled accordingly. The inoculated roots were placed in clean polyethylene bag (one root per bag) each moistened with wet balls of absorbent cotton wool to create a humid environment and incubated for 7 days at room temperature (28 ± 2°C). The same procedure was used for the control except that discs of un-inoculated PDA were placed in the holes created in the tubers. After the incubation period, the roots were individually weighed and cut open through the point of inoculation. The interface between rotted and healthy tissue was well defined in all infected roots. The rotted portions were removed from the whole roots and the final weight of the individual sweet potato roots taken. The causal agents were re-isolated from the infected sweet potato roots and compared with the original isolates, followed by determination for fungi severity and cultivar susceptibility. This experiment was replicated two times.

**2.4 Fungi Severity**

The percentage severity of rot (Sr %) was calculated as described by Ogbo and Agu (2014) :

$$\mathrm{Sr}\ (\%) = \frac{W - w\ \times 100}{W}$$

Where:
W = Initial weight of healthy Sweet potato root;
w = final weight of rotted tuber portion.

**2.5 Sweet Potato Cultivar Susceptibility**

The susceptibility of the two varieties of sweet potato was determined using the Mean Weight of rotted tissue per cultivar (Lewthwaite et al., 2013) (determined as the difference between the initial root weight after inoculation and the weight after rot removal).
Cultivar Susceptibility (g/root) = Mean Weight of rotted tissue per cultivar = W-w
Data was subjected to ANOVA and difference between means separated using DUNCAN multiple Range test

## 3. RESULTS

**3.1 Fungi Severity**

In this study, no disease symptoms developed on roots wounded but inoculated with disc of sterile PDA. As posits in Table 1, the fungi/sweet potato cultivar interaction varied among the seasons, being higher in dry season (49.51% and 41.41% respectively for cultivar Tupiaochi and Oyorima) and lower in the rainy season. The results revealed that in the first phase, the severity of the test fungi on both sweet potato cultivars was significantly different except for those of P. expansum and A. awamori. R. oryzae recorded the highest mean rot severity index of 76.36% on both sweet potato cultivars (80.87% and 71.84% respectively for 'tupiaochi' and 'Oyorima') followed by A. niger with mean rot severity index of 68.39% on both sweetpotato cultivars (78.52% and 58.25% respectively for tupiaochi and Oyorima); B. theobromae (mean rot severity index of 64.06% on both sweet potato cultivars (74.20% and 53.91% respectively for tupiaochi and Oyorima); F. solani (mean rot severity index of 34.29% on both sweet potato cultivars (34.65% and 33.92% respectively for tupiaochi and Oyorima); A. flavus, A. awamori and P. expansum with mean rot severity index of 32.03%, 22.73% and 20.39% respectively on both sweet potato cultivars within the test period (dry season).

***Table 1:*** *Severity of fungi implicated with postharvest spoilage in the two varieties of sweet potato in Ebonyi State*

| Treatment/ Pathogen | Pathogen Severity (mean %) | | |
|---|---|---|---|
| | Dry Season | | |
| | Tupiaochi | Oyorima | Total Pathogen Means |
| | Mean rot severity index | Mean rot severity index | Mean rot severity index |
| Control | (0) | (0) | (0) |
| B. theobromae | $74.20_a$ (5) | $53.91_{ab}$ (5) | 64.06 (5) |
| A. flavus | $34.65_a$ (4) | $29.61_{ab}$ (4) | 32.03 (4) |
| R. oryzae | $80.87_a$ (5) | $71.84_{ab}$ (5) | 76.36 (5) |
| F. solani | $27.89_a$ (4) | $33.92_{ab}$ (4) | 34.29 (4) |
| A. niger | $78.52_a$ (5) | $58.25_{ab}$ (5) | 68.39 (5) |
| P. expansum. | $21.02_a$ (3) | $19.76_a$ (3) | 20.39 (3) |
| A. awamori | $22.85_a$ (3) | $22.60_a$ (3) | 22.73 (3) |
| Total Cultivar Means | $49.51_a$ (4) | $41.4_{ab}$ | |
| | Rainy Season | | |
| Control | 0 | 0 | 0 |
| B. theobromae | $70.65_a$ (5) | $54.12_{ab}$ (5) | 62.39 (5) |
| A. flavus | $34.44_a$ (4) | $26.21_{ab}$ (4) | 30.33 (4) |
| R. oryzae | $77.89_a$ (5) | $54.39_{ab}$ (5) | 66.14 (5) |
| F. solani | $23.60_a$ (3) | $32.22_{ab}$ (4) | 27.91 (4) |
| A. niger | $74.1_a$ (5) | $53.91_{ab}$ (5) | 64.01 (5) |
| P. expansum | $20.98_a$ (3) | $16.99_{ab}$ (3) | 18.99 (3) |
| Total Cultivar Means | $50.28_a$ (5) | $39.64_b$ (4) | |

Values are means of two replicates.
Pathogen Means with different subscript are significantly different
(Figures in Parenthesis) = Pathogen Severity ranking viz:

0 = none pathogenic fungi (no rots);
1= Very mild pathogen severity (1-5%);
2= Mild pathogen severity (10%);
3= Moderate pathogen severity (>10-25%),
4= High pathogen severity (>25-50%);
5 =Very high pathogen severity (> 50%)

### 3.2 Sweet Potato Cultivar Susceptibility to Rot

The susceptibility of the sweet potato cultivars to postharvest fungi is presented in Figure 1. None of the sweetpotato cultivars evaluated under laboratory conditions appeared immune to the pathogens; that is, both sweet potato cultivars showed typical rot symptoms with the root tissue rotting around the inoculation point within two weeks of inoculation. However, the mean weights (g/root) of rotted tissue varied significantly among the 3 evaluated cultivars in both the 1st and 2nd trials. The control roots showed no tissue degradation. The Cultivar x pathogen interaction for cultivar 'Tupiaochi' (38.08 and 38.67g/root in the dry and rainy season respectively) was significantly higher than that of 'Oyorima' (29.80 and 29.53g/root). 'Tupiaochi' clone exhibited 'very high susceptibility' (>50%) towards three pathogens in both trials: R. oryzae, A. niger and B. theobromae showed significantly different responses (65.86, 60.80 and 56.97g/root in first trial and 59.25, 55.16 and 52.30g/root respectively in the second trial), 'high susceptibility' (>25-50%) towards A. flavus (30.45g/root) and 'moderate susceptibility (>10-25%) towards F. solani, P. expansum and A. awamori with statistically significantly different (P<0.05) responses (23.82, 15.29 and 12.81g/root respectively). 'Oyorima' cultivar exhibited a 'very high susceptibility' (>50%) towards R. oryzae, (54.02g/root respectively), 'high susceptibility' (>25-50%) towards A niger, B. theobromae and F. solani wiith statistically significantly different (P<0.05) responses (45.17, 34.03 and 27.03g/root respectively) and 'moderate susceptibility (>10-25%) towards A. flavus, P. expansum and A. awamori with significantly different (P<0.05) responses (22.38, 14.05 and 11.93g/root respectively).

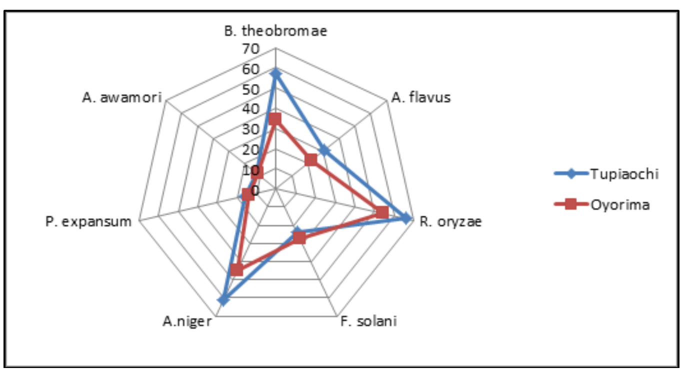


***Figure 1:*** *Mean weights (g/root) of rotted tissue in storage roots of sweet potato (Ipomoea batatas)*

## 4. DISCUSSION

### 4.1 Fungi severity

Findings on fungi severity showed that the rot severity exhibited by the fungi ranged from very moderate severity to very high severity. All fungal pathogens were more severe in the dry season than in the rainy season. R. oryzae exhibited the highest percentage severity of rot in both cultivars and seasons while P. expansum displayed the lowest severity. The highest severity index recorded by R. oryzae in this study lends credence to report by Clark et al. (2009) that soft rot is internationally considered one of sweet potato's most important postharvest diseases [3]. As reported by Scot (2009), pectolytic and other enzymes produced by Rhizopus spp quickly cause host discoloration and liquefy host tissues [10]. Uncured sweet potatoes are more prone to damage by all the postharvest fungi than are cured sweet potatoes. Therefore there is the need to educate the farmers on the need for adequate and proper curing of their sweet potato produce before storage.

### 4.2 Cultivar Susceptibility

Results of the relative susceptibility revealed that the two sweet potato varieties known as 'Tupiaochi' and 'Oyorima' were susceptible to the phytopathogens prevalent in the area, cultivars showing a significant range of responses. Sweet potato cultivar Tupiaochi was considered more susceptible to fungal infection in the dry season than in the rainy season. Several factors can affect root susceptibility to infection. Sweet potato root susceptibility to some fungal diseases may change during storage and with wound type. Sweet potatoes stored for long periods of time after harvest are more susceptible to rot, especially soft rot disease. Other causes and implications of variation in susceptibility to pathogenic infections have been suggested and discussed by several authors [4] and [2]. According to May and Anderson reported by Arash et al. [2], variation in susceptibility to pathogenic infections is a function of the host genetic structure. Arash et al. (2013) added that constant genotype-by-environment interactions can influence the degree of disease expression in host plants; they gave examples of the environmental variables including, but not limited to, ambient incubation temperature, host nutrient status and host age [2]. The Cultivar variability in susceptibility to the postharvest fungi exhibited by the tested sweet potato cultivars in this study also showed that it is possible to pursue host resistance as a means of controlling postharvest rot in some sweet potato cultivars. It will be rational to infer that because of their susceptibility and consequent poor storability, most farmers sell their produce just after harvest to avoid losses, resulting in low income or reduced profits; a practice that also affects farmers' food security particularly in the lean season. The results show that all the cultivars were very susceptible to infection by the pathogens in the first trial (dry season) than in the second trial (wet season). This might be due to differences in the prevailing temperature during incubation. During the first trial, the ambient temperature ranged from $22^0$C to $28^0$C and in the second trial ranged from $20^0$C to $25^0$C (Alum, et al., 2019a), thus the temperature during the first trial may have provided a more favourable environment for pathogen activity, thus enhancing infection.

## 5 CONCLUSIONS

The postharvest fungi affecting sweet potato in Ebonyi State exhibit moderate to very high severity on the roots and the local varieties of sweet potato ('Oyorima' and 'Tupiaochi') cultivated in Ebonyi State are highly susceptible to postharvest fungal rot and vary with the pathogen and sweet potato cultivar. Therefore there is the need to regulate the storage environment for sweet potato roots since cultivar susceptibility to infection is influenced by the prevailing environmental conditions. While the susceptibility of both sweet potato cultivars indicates that cultivar tolerance cannot be employed now as a decay control alternative to synthetic fungicides, the cultivar variability in susceptibility to the postharvest fungi exhibited by the tested sweet potato cultivars shows that it is possible to pursue host resistance as a means of controlling postharvest rot in some sweet potato cultivars. The use of improved sweet potato varieties, good storage facilities and adequate control measures need to be encouraged in order to reduce storage rot of sweet potato roots in Ebonyi State. There may be the need to study and identify the underlying mechanisms and key genetic factors involved in fungi rot susceptibility variations using a differential expression analysis technique.

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